^{4}He Adsorption on H_2-preplated C_{20}

S. Shim and Y. Kwon

Department of Physics, Konkuk University, Seoul, Korea

We have studied adsorptions of H_2 molecules and ^{4}He atoms on the surface of a C_{20} fullerene molecule by using path-integral Monte Carlo method. Fully-anisotropic substrate potentials described by the sum of all pair potentials between H_2 or ^{4}He adatom and twenty carbon atoms are employed to incorporate corrugation effects on the C_{20} molecular surface. Radial density distributions show layer-by-layer growth and the first adlayer is found to be completed with thirty-two H_2 molecules. Detailed analysis of angular density distributions reveals that the completed hydrogen monolayer exhibits an ordered state where each of thirty-two H_2 molecules is located either above one of the twelve pentagon centers of the C_{20} molecular surface or above one of the twenty carbon atoms. We find total suppression of hydrogen superfluidity in the completed monolayer while a partially-filled monolayer may show significant superfluid response at low temperatures below $T = 1.0$ K. On the other hand a single layer of ^{4}He atoms adsorbed on top of the completed hydrogen monolayer around a C_{20} molecule shows different quantum states depending on the number of helium adatoms. A commensurate solid structure with respect to the underlying H_2 monolayer is found in a layer consisting of $N = 80$ ^{4}He atoms. Finally we discuss formation of mobile vacancy states and possible realization of nanosclae supersolidity in this ^{4}He adlayer.